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Friis Pedersen, Troels; Gottschall, Julia; Frandsen, Sten Tronæs; Runge Kristoffersen, Jesper; Dahlberg, Jan-Åke; Christiansen, Wolfgang; Weich, Günther; Ormell, Frank

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APPLICATION OF SPINNER ANEMOMETRY IN YAW ALIGNMENT CONTROL

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T.F.Pedersen (1), J.Gottschall (1), J.R. Kristoffersen (2), J-Å.Dahlberg (2), W.Christiansen, (3), G.Weich (3), J.Wedell-Heinen (4)
(1) Risoe DTU, (2) Vattenfall ,(3) Metek, (4) Vestas

Abstract

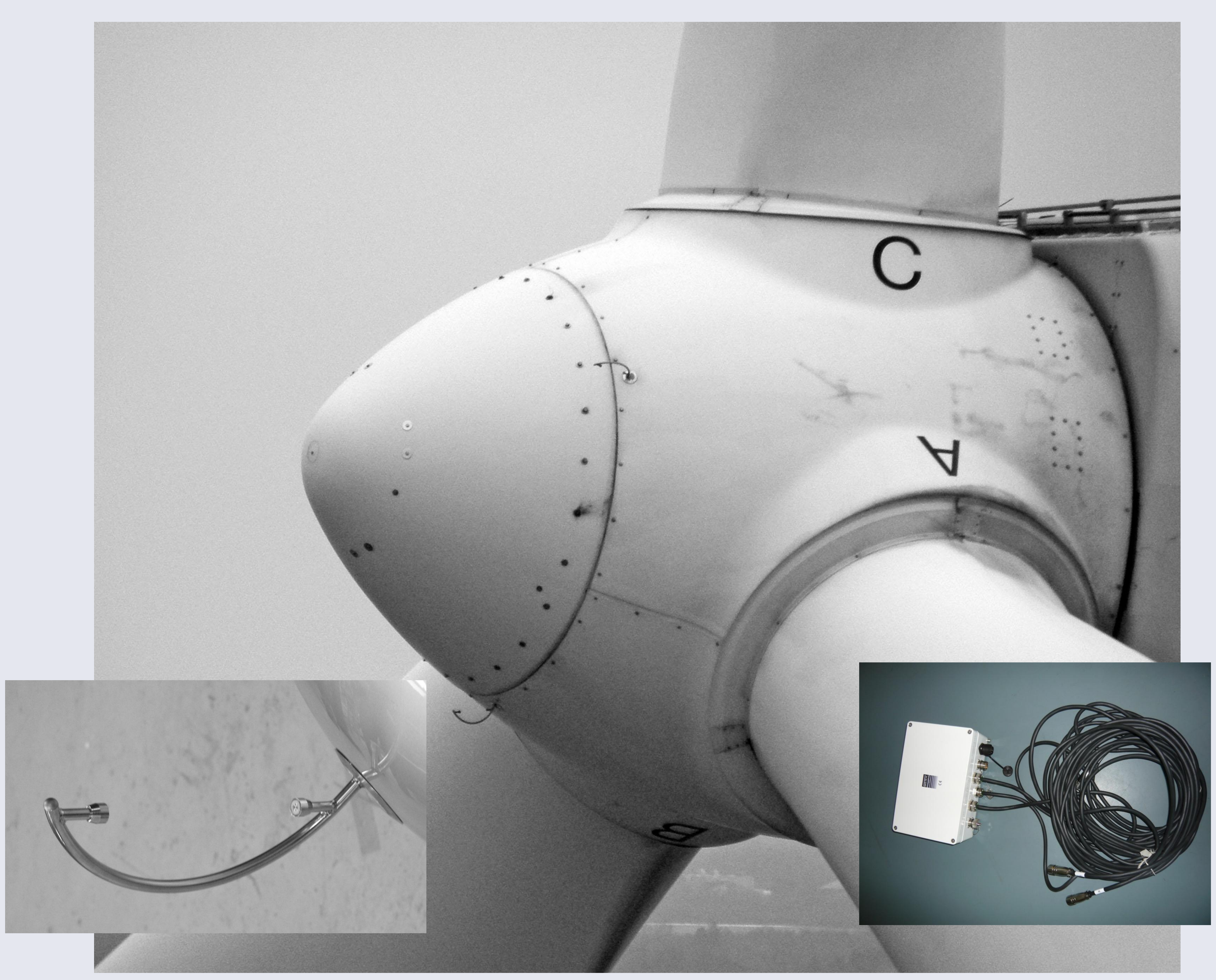
The state of the art in yaw alignment control is based on nacelle anemometry. However, nacelle anemometry is very complex, and this gives rise to unnecessary yaw errors which reduces power and increases loads. A new concept, spinner anemometry, is a wind measurement principle which eliminates errors in yaw error measurements, see ref. 1. Measurements on a full size wind turbine with this concept were made for the first time in 2008, see ref. 2 and 3. The spinner anemometer concept is now used in the project "Spinner-Farm" for yaw alignment control to optimize power. First, tests and optimizations on a single on-land turbine are made. Then tests are performed on a whole row of turbines in an off-shore wind farm.

Objectives

The objective is to optimize yaw alignment of wind turbines and expectedly to increase power performance by 1-5%. Parts of the objective are to determine and document yaw error statistics, performance reduction as function of yaw error, and the performance increase of a wind farm.

Methods

A spinner anemometer has been mounted on the spinner of a Vestas on-shore 2MW wind turbine at Tjæreborg in Jutland DK, similar to the 80 off-shore Horns Reef wind turbines. Installation procedures are optimized in order to install spinner anemometers on the off-shore wind turbines during normal service visits to the turbines. First, yaw errors are measured on the on-shore turbine without control interaction. Then the spinner anemometer is connected to the control system to align the turbine with the wind. Systematic offsetting the alignment is carried out to investigate performance reduction as function of the yaw error. The expected performance reduction is a $\cos^2$ relationship.



The figure above show the spinner anemometer with conversion box and cables, and the sonic sensors mounted on the spinner. The anemometer consists of three sonic sensors (one shown to the left), a rotor position sensor (integrated with the sonic sensors) and a conversion box with cables (right). The sonic sensors were mounted with the use of a template, holes were drilled from the inside and each fitting was mounted from the outside from the top of the spinner/hub. The sensor output is a serial output of wind speed, yaw error and flow inclination angle, with both instantaneous values and moving 30s average values. Air temperature and a status signal is also output. Heating is integrated in the sonic sensors to prevent icing on the sensor heads. In the first place, the spinner anemometer transfers data via a wireless connection. In the second place it is connected to the wind turbine control box in the spinner.

A mast is instrumented with cup and vane anemometry in order to calibrate the two K-factors of the spinner anemometer for the specific spinner and turbine configuration, see below. One K-factor relates to wind speed, the other to flow inclination.

Results

So far the installation of the spinner anemometer on the on-land turbine has resulted in a learning experience. The installation was positioned on the spinner at a place where it is well shielded, and a more efficient template has been designed. The on-shore wind turbine will be used to optimize installation time on the off-shore turbines. An expressed goal is to install a spinner anemometer by two service technicians in two hours during a normal service visit. Installations on the offshore turbines will take place summer 2010. The ten installations will be made in a pattern that statistically includes all possible row positions from the front row to the last row. A candidate row is a middle row going east-west. The two neighboring rows will be used to compare statistics of performance and yawing errors before and after spinner anemometers are connected to the wind turbine control system. Measurement campaigns will be carried out from summer 2010 to summer 2011.

Conclusions

The project "Spinner-Farm", under the Danish EUDP research program, has been initiated with installation of a spinner anemometer on an on-shore wind turbine. Experiences have been gained on installation, and mounting procedures have been optimized for off-shore installations. The measurement campaign on the on-shore wind turbine has started, and off-shore installations are planned for summer 2010, and measurement campaigns on off-shore turbines will continue until summer 2011.

References

1. Pedersen TF, Madsen HA, Møller R, Courtney, M, Sørensen NN, Enevoldsen P, Egedal P, "Spinner Anemometry – An Innovative Wind Measurement Concept", EWEC2007 Milan
2. Pedersen TF, Vita L, Sørensen NN, Enevoldsen P, "Operational Experiences with a Spinner Anemometer on a MW Size Wind Turbine", EWEC2008, Bruxelles
3. Pedersen TF, Vita L, Sørensen NN, Enevoldsen P, "Optimization of Wind Turbine Operation by Use of Spinner Anemometer", Risø-R-1654(EN), 2008

Contact: Troels Friis Pedersen, trpe@risoe.dtu.dk, +45 2133 0042